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INFLUENCE OF PRE-HARVEST FOLIAR APPLICATION OF NUTRIENTS AND GROWTH REGULATORS ON FRUIT QUALITY OF LITCHI (*Litchi chinensis* Sonn.) CV. ROSE SCENTED

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ABSTRACT : In order to maintain and enhance fruit quality and storability of litchi the present study was conducted at Horticultural Research Centre, GBPUA&T, Pantnagar, Uttarakhand during 2013-14 and 2014-15. Different pre-harvest sprays of nutrients and growth regulators were sprayed individually or in combination with each other, viz., calcium chloride @ 0.5%, potassium sulphate @ 0.5%, borax @ 1%, putrescine @ 40ppm, salicylic acid @ 100ppm and ascorbic acid @ 0.2% on litchi to ascertain their effect on fruit chemical characters. The analytical study of the data revealed that treatment with a combination of $CaCl_2$+ K_2SO_4 + Borax @ 0.5 % + 0.5 % + 1.0 % had best effect on TSS (21.05 °B), titratable acidity (0.44 %), ascorbic acid (28.16 %), total sugars (15.39 %), reducing sugars (11.48 %), non-reducing sugars (3.90 %) and TSS: acid ratio (31.62).

Keywords : *Litchi, calcium chloride, potassium sulphate, borax, chemical characters.*

Litchi (*Litchi chinensis* Sonn.) is an evergreen, subtropical fruit tree native to southern China. It belongs to family Sapindaceae of which minor fruit crops like Longan, Rambutan and Pulsan are members. It is highly specific to climatic requirements and its cultivation is restricted to only a few countries (Singh and Babita, 12). It has a strong commercial value in international markets for its bright red skin and sweet, juicy and crisp aril (Holcroft and Mitcham, 6; Jiang *et al.* 7). In India, it is mainly grown in Bihar, West Bengal, Uttar Pradesh, Punjab and Uttarakhand. In Uttarakhand, major litchi producing districts are Dehradun, Haridwar, Nainital and U.S.Nagar. Currently, Bihar contributes 45% of total litchi production and occupies nearly 40% of the area under litchi plantation in the country.

Litchi being a non-climacteric fruit, does not improve in quality after harvesting but has to ripen on the tree (Chen *et al.,* 3). Harvesting at proper physiological maturity is essential for true quality and shelf life. However, the fruits after harvest are very perishable and rapidly loose quality (Nip, 9 and Ray, 11). Pericarp browning, desiccation, loss of quality, post harvest decays and micro cracking are major constraints affecting commercial quality during storage and transportation (Sivakumar *et al.,* 13). Nutrient foliar applications prior to harvest to improve quality and decrease deficiencies are common practices in fruit production (Ernani *et al.*, 4). Foliar fertilization of nutrients has advantage of lower application rates, uniform distribution of nutrients and quick response to applied nutrients. Application through foliage can be 10 to 20 times more effective than soil application (Zaman and Schumann, 14). Hence, for improvement of quality and shelf life of litchi fruits, pre-harvest application of chemicals like $CaCl_2$, Borax, K_2SO_4, Putrescine etc. may show fruitful results as these are known to increase peel strength which eventually can avoid fruit cracking thereby maintaining fruit quality.

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MATERIALS AND METHODS

The present study was carried out at the Horticultural Research Centre, Patharchatta and the Department of Horticulture, G.B. Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand during the years 2013-14 and 2014-15. Twenty five years old bearing litchi trees of cv. Rose Scented of uniform vigour and size were selected for study at Horticultural Research Centre, Patharchatta. Treatment details are given in Table 1.

All the litchi trees were maintained uniform under cultural practices during the course of investigation. The experiment was laid out in a Randomized Block Design (RBD) with 10 treatments + 1 control. All the treatments, including control were replicated three times and one tree served as a unit of treatment in each replication. Thus 33 trees were marked for the experiment. Fruits were harvested at random for extraction juice and evaluation of chemical quality parameters like TSS, titratable acidity, ascorbic acid

content, total sugars, reducing sugars and non-reducing sugars and TSS: acid ratio.

The spray of each chemical was done three times during both years *i.e.,* 2013-14 and 2014-15.

1. 1st spray at 45 days before date of harvesting.
2. 2nd spray at 30 days before date of harvesting.
3. 3rd spray at 15 days before date of harvesting.

For spraying each one of 33 trees, 15 litres solution each of different chemicals was used. Prepared chemical solutions were sprayed using foot sprayer in order to cover whole tree foliage as well as fruit panicles during daytime on specified date.

The stock solution of different chemicals was prepared on the spot by dissolving them in appropriate volume of solvents i.e., distilled water or ethanol and final volume for spraying was prepared by adding 15 litres of simple water. The pH of solution was adjusted to neutral by adding 0.1 N NaOH and 0.1 N HCl. Surfactant Tween-20 was added in order enhance the effectiveness of sprays.

Analysis of chemical quality parameters

TSS content of the fruit juice (aril extract) was recorded by using hand refractometer at room temperature. Refractometer was set at zero with distilled water before recording TSS values of fruit juice. The values were expressed in °B.

Total acid content of litchi fruits was calculated by titrating the pulp extract with N/10 NaOH as per described by Ranganna (10) using 1 per cent phenolphthalein as indicator. Since the predominant acid of ripe litchi fruit is malic acid (80% of all the acids), the calculation of total acidity was based on the equivalent weight of malic acid. Titratable acidity was expressed in terms of percentage.

Ascorbic acid content of aril was determined according to the methods described by Ranganna (10). The aril was weighed and ground in mortar and pestle by adding 3% metaphosphoric acid (HPO_3) solution. The solution so obtained, was used for titrating against the dye (2,6- dichlorophenol-indophenol) till the pink colour appeared (end point). The titre value was recorded and calculation was done. Ascorbic acid content was expressed as mg per 100 g pulp.

Total sugar content in fruit juice was determined as per 'Lane and Eynon Method' (Ranganna, 10). 50ml filtered juice was mixed with 100ml distilled water and neutralized with 0.1 N NaOH solution using phenolphthalein as indicator and the solution was allowed to stand for ten minutes. Then 8ml of potassium oxalate solution was added and total volume was made up to 250ml by adding distilled water. 5ml of the extract was taken in burette and titrated against 10 ml mixed Fehling's (5ml Fehling's solution A + 5ml Fehling's solution B) using methyl blue as indicator. The end point indicated by decolourization of the solution. The following formula was used for determining the total sugar in fruits.

RESULTS AND DISCUSSION

Total soluble solids

It is evident from the data (Table 1) that the different treatments had a significant effect on total soluble solids of fruit. During the year 2013-14, significantly higher total soluble solids (21.08 °B) was recorded with the T_{10} which was at par with T_2 (20.32 °B), T_7 (20.66), T_8 (20.82 °B), T_9 (20.49 °B) while minimum (19.41 °B) was observed in control (T_0). Second year results (2014-15) revealed that maximum TSS was depicted in T_{10} (21.02 °B) which was at par with T_7 (20.55 °B), T_8 (20.67 °B) and T_9 (20.41 °B) while minimum (19.15 °B) was recorded in T_0 (control). Total soluble content was higher fruits treated with T10 treatment it might be due to rapid mobilization of sugars and other soluble solids to developing fruits. These findings are in complete conformity with results of Alila and Achumi (1) and Nath *et al.* (8).

Titratable acidity

In the first year 2013-14 (Table 1), T_{10} treatment revealed minimum (0.44 %) titratable acidity which was highly significant over rest of the treatments except T8 treatment (0.45%) with which it was at par. While, highest titratable acidity (0.55%) was recorded in T_5 treatment (Salicylic acid). In the year 2014-15, again minimum titratable acidity (0.45%) was noted under T_{10} treatment which was highly significant over all the other treatments except T_8 (0.46%) with which it was at par, while maximum titratable acidity was recorded under T_5 treatment (0.56 %). The highest titratable acidity in salicylic acid treatment is due to its ability hinder the ripening process *i.e.,* prevents the rapid conversion of acids into sugars maintaining high acidity in fruits. These results substantiated the findings of Nath *et al.* (8).

Ascorbic acid

In the year 2013-14 (Table 2), the maximum ascorbic acid content (28.22 mg/100g) was recorded in T_{10} treatment which was at par with T_6 (27.56 mg/100g), T_7 (27.45 mg/100g), T_8 (28.19 mg/100g) and T_9 (27.95 mg/100g) while the minimum ascorbic acid content (26.42 mg/100g) was recorded with the

Table 1: Effect of different treatments on TSS and titratable acidity of litchi cv. Rose Scented.

Treatments	Fruit TSS (°B)			Titratable acidity (%)		
	2013-14	2014-15	Pooled mean	2013-14	2014-15	Pooled mean
T_0 : Control	19.41	19.15	19.28	0.54	0.55	0.54
T_1 : $CaCl_2$(0.5%)	20.32	20.17	20.25	0.49	0.52	0.50
T_2 : K_2SO_4 (0.5%)	19.84	19.60	19.72	0.51	0.52	0.51
T_3 : Borax (1%)	20.10	19.84	19.97	0.50	0.50	0.50
T_4 : Putrescine (40ppm)	19.54	19.39	19.47	0.53	0.54	0.53
T_5 : Salicylic acid (100ppm)	19.55	19.35	19.45	0.55	0.56	0.55
T_6: Ascorbic acid 0.2 %	19.47	19.29	19.38	0.52	0.53	0.52
T_7: $CaCl_2$ (0.5%) + K_2SO_4 (0.5%)	20.66	20.55	20.60	0.46	0.47	0.46
T_8: $CaCl_2$ (0.5%) + Borax (1%)	20.82	20.67	20.74	0.45	0.46	0.45
T_9: Borax (1%) + K_2SO_4 (0.5%)	20.49	20.41	20.45	0.48	0.49	0.48
T_{10}: $CaCl_2$ (0.5%) + Borax (1%) + K_2SO_4 (0.5%)	21.08	21.02	21.05	0.44	0.45	0.44
CD (P=0.05)	0.86	0.93	0.98	NS	0.16	0.12

treatment T_0 (control). Similar results were obtained in the next year *i.e.,* 2014-15. Results obtained regarding ascorbic acid are in conformity with Brahmachari *et al.* (2) and Nath *et al.* (8).

Total sugars

In the first year, highest total sugar content (Table 2) was noticed under T_{10} treatment (15.15 %) which was closely followed by T_8 treatment (15.07 %), while lowest total sugars content was recorded in control treatment (13.42 %). In the following year *i.e.,* 2015 T_{10} exhibited maximum total sugars (15.63 %) with T8 treatment trailing behind with total sugars content of 15.42 % which were at par with each other and minimum total sugars recorded in T_0 (13.91 %). Increase in total sugars is attributed to rapid conversion of starch into sugars which is augmented by calcium and boron nutrients. Such beneficial effect of treatments on sugars is corroborated by the findings of Brahmachari *et al.* (2).

Table 2: Effect of different treatments on ascorbic acid and total sugars of litchi cv. Rose Scented.

Treatments	Ascorbic acid (mg/100g)			Total sugars (%)		
	2013-14	2014-15	Pooled mean	2013-14	2014-15	Pooled mean
T_0: Control	26.42	26.18	26.30	13.42	13.91	13.67
T_1: $CaCl_2$(0.5%)	27.31	27.20	27.26	14.57	15.13	14.85
T_2: K_2SO_4 (0.5%)	26.77	26.60	26.68	13.73	14.26	13.99
T_3: Borax (1%)	26.72	26.29	26.50	14.38	14.70	14.54
T_4: Putrescine (40ppm)	26.94	26.81	26.87	14.00	14.35	14.18
T_5: Salicylic acid (100ppm)	27.56	27.46	27.51	14.09	14.42	14.26
T_6: Ascorbic acid 0.2 %	27.45	27.33	27.39	13.90	14.16	14.03
T_7: $CaCl_2$ (0.5%) + K_2SO_4 (0.5%)	27.32	27.10	27.21	14.82	15.23	15.02
T_8: $CaCl_2$ (0.5%) + Borax (1%)	28.19	27.91	28.05	15.07	15.42	15.25
T_9: Borax (1%) + K_2SO_4 (0.5%)	27.95	27.69	27.82	14.66	14.84	14.75
T_{10}: $CaCl_2$ (0.5%) + Borax (1%) + K_2SO_4 (0.5%)	28.22	28.09	28.16	15.15	15.63	15.39
CD (P=.05)	1.17	1.04	1.30	0.09	1.18	0.96

Table 3: Effect of different treatments on reducing and non-reducing sugars of litchi cv. Rose Scented.

Treatments	Reducing sugars (%)			Non -reducing sugars (%)		
	2013-14	2014-15	Pooled mean	2013-14	2014-15	Pooled mean
T_0 : Control	10.28	10.48	10.38	3.14	3.43	3.28
T_1 : $CaCl_2$(0.5%)	11.01	11.23	11.12	3.55	3.90	3.73
T_2 : K_2SO_4 (0.5%)	10.35	10.75	10.55	3.37	3.50	3.44
T_3 : Borax (1%)	10.77	10.92	10.84	3.61	3.78	3.69
T_4 : Putrescine (40ppm)	10.61	10.86	10.74	3.39	3.49	3.44
T_5 : Salicylic acid (100ppm)	10.52	10.78	10.65	3.56	3.64	3.60
T_6 : Ascorbic acid 0.2%	10.42	10.69	10.55	3.39	3.47	3.43
T_7 : $CaCl_2$ (0.5%) + K_2SO_4 (0.5%)	11.08	11.41	11.25	3.74	3.81	3.77
T_8 : $CaCl_2$ (0.5%) + Borax (1%)	11.17	11.48	11.32	3.90	4.27	4.08
T_9 : Borax (1%) + K_2SO_4 (0.5%)	10.98	11.13	11.05	3.68	3.70	3.69
T_{10} : $CaCl_2$ (0.5%) + Borax (1%) + K_2SO_4 (0.5%)	11.35	11.62	11.48	3.80	4.01	3.90
CD (P=0.05)	0.71	0.73	0.74	0.48	0.43	0.44

Reducing Sugars

In the year 2013-14 (Table 3), the reducing sugars content ranged from maximum (11.35 %) in T_{10} ($CaCl_2$ + Borax + K_2SO_4) to minimum (10.28 %) in control treatment. The reducing sugar content of T_{10} was at par with T_1 (11.01 %), T_7 (11.08%), T_8 (11.17%) and T_9 (10.98 %). In the next year, highest reducing sugars content (11.62 %) was recorded under T_{10} which was at par with T_1 (11.23 %), T_7 (11.48 %), T_8 (11.13%) and T_9 (11.13 %) while lowest reducing sugars (10.48 %) was noticed in control (T_0) fruits. Present results are in line with the findings of Haq *et al.* (5).

Non-reducing sugars

During the first year (Table 3), treatment T_8 recorded significantly higher non-reducing sugars (3.80%) followed by T_{10} (2.80%) and T_7 (3.74%) over control treatment (3.14%) which recorded the lowest non reducing sugars. In the year 2015, again T_8 recorded significantly maximum non-reducing sugar content (4.01 %) over control treated fruits (3.43 %) but at par with rest of the treatments except few.

CONCLUSION

On the basis of results summarized above, it can be concluded that quality of litchi fruits can be influenced by the pre-harvest application of different treatments. For obtaining good quality and higher shelf-life in litchi fruits trees should be sprayed with Calcium Chloride ($CaCl_2$ @ 0.5%) + Potassium Sulphate (K_2SO_4 @ 0.5%) + Borax @1% three times at fortnightly interval from forty five days before harvest date during morning hours.

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